NOVEMBER 2000 PROGRESS REPORT
TSUNAMI INUNDATION MAPPING

F. González and V. Titov (NOAA/PMEL/TIME)

The individual State reports are presented in Appendix A. The following table and the key points presented below the table summarize the status of inundation mapping in each State.

STATE	COMPLETE	IN PROGRESS	FY01 PLANS
ALASKA		Kodiak Women's Bay USCG Base	Homer-Seldovia
CALIFORNIA	San Diego Los Angeles Santa Barbara San Francisco-San Mateo		Central Coast, including Monterey Bay Morro Bay
HAWAII	**Local Tsunamis:** 1975 Kalapana **Distant Tsunamis:** AASZ Sources	**Local Tsunamis:** Kona Coast Honolulu **Distant Tsunamis:** 1964 Alaska	**Local Tsunamis:** Kona Coast Honolulu South Maui Hilo Kilauea sector collapse **Distant Tsunamis:** 1964 Alaska
OREGON	Coos Bay		Waldport Rockaway Florence
WASHINGTON		Juan de Fuca St. Port Townsend Port Angeles Neah Bay La Push	Puget Sound

ALASKA

- Propagation code transferred from old to new supercomputer runs 10 times faster
- Reference level problem with Kodiak area grid under investigation
- Inundation code testing underway

CALIFORNIA

- Maps delivered to San Diego, Los Angeles, Santa Barbara and San Mateo/San Francisco officials
- Los Angeles mitigation/preparedness program well underway
- Contract in preparation for USC mapping of central California coast
- Monterey Bay and Morro Bay will require special effort: bathy, topo, and slide potential assessment.

HAWAII

- Distant source study (uses Green's function inversion of water level data):

- Completed database of synthetic waveforms for AASZ sources
- Hypothetical events used to test database and methodology
- 1964 Alaska event will test practical application

• Local source study
- 1975 Kalapana simulation completed for model verification
- Kona sensitivity analysis underway on Maui High Performance Computing Center Supercomputer
- Honolulu inundation map in preparation
- Merged bathy/topo grid production difficult and slow

OREGON

• Coos Bay inundation lines being drawn for preliminary field check and review

WASHINGTON

• Late delivery of bathy/topo data delayed Straits of Juan de Fuca simulations

APPENDIX A. Individual State Reports

ALASKA

Subject: Re: Alaska Inundation Mapping Progress Report
Date: Thu, 02 Nov 2000 09:15:01 -0900 (AKST)
From: Elena Suleimani <elena@giseis.alaska.edu>
To: gonzalez@pmel.noaa.gov
CC: roger@kiska.giseis.alaska.edu

November 1, 2000.

Report from Geophysical Institute, UAF:

1. We continue to work on the optimization and parallelization of the code running on the Cray platforms. Most of the subroutines in the code are generalized to work on all of the grids. A grid "type" containing all of the arrays and settings for each grid is set to make it easier to apply the model to a different geographical area. Recently, the propagation code was tested on the new 32-processor Cray SV1 which replaced the old Cray J90 at the Arctic Region Supercomputer Center in September. The code runs between 6 and 16 times faster at different numbers of processors, and the fastest SV1 time is about 10 times faster than the best J90 time.

2. Three more data sets have arrived from NOAA TIME. They cover Kodiak City, US Coast Guard Base and Women's Bay. Each of these data sets is a combination of bathymetry and topography and will be used in runup calculations. The resolution of the data is 1.33"x0.88", which is about 22x27 meters. The runup grids are constructed based on these data sets. They will be interactively embedded into the Kodiak grid of 2.67" resolution.
We noticed some discrepancy in reference levels for these grids. The grids are referenced to MHHW, but the shoreline generated using the Kodiak City data set runs below the MHW shoreline of the USGS topographic map which will be the "base map" for inundation plots.

3. The runup algorithm is being tuned using different test geometries as well as the current runup data sets.

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CALIFORNIA

Progress Report on Inundation Mapping in California

Jose Borrero and Costas Synolakis
University of Southern California
www.usc.edu/dept/tsunamis

October 2000

We submitted to OES our final version of the inundation maps in June of 2000. These recommendations for predicted maximum tsunami runup and inundation were the combined product of inundation modeling and on site surveys.

Despite the fact that our contract with California OES had expired and we were in the process of applying for a renewal, we continued our inundation modeling especially the San Diego region. We are attempting to integrate new scenarios that are being developed with the assistance of Dr. Mark Legg of Legg Geophysical, These scenarios consider earthquake rupture on restraining bends of the San Clemente Fault. Preliminary simulations do not appear to increase the maximum runup predictions for the San Diego Region. They will however, add to the existing database of completed runs and aid in future probabilistic studies.

In anticipation of further work along the California coast, we will need of bathymetric data for the central coast. Areas that will need special consideration are Monterrey Bay and Morro Bay. Also, we may need some assistance in reconfiguring some nearshore and coastline bathymetry in Orange County. To date, this region has not been modeled in detail. Also, we need marine geology data around Monterey Bay to evaluate the likelihood of coseismic slides.

In the same period we submitted one manuscript to Geophysical Research Letters on our modeling of the Santa Barbara coastline. We submitted an abstract detailing the sources on the San Clemente Fault to the International Tsunami Symposium set for August 2001 in Seattle. We will also present the procedures used to generate the tsunami hazard and evacuation maps at the Fall AGU meeting in San Francisco.

Subject: Re: California Inundation Mapping Progress Report
Date: Tue, 24 Oct 2000 15:38:14 -0700
From: Rich_Eisner@oes.ca.gov
To: gonzalez@pmel.noaa.gov

We delivered copies of the maps for San Diego, LA, Santa Brbara and San Mateo/San Francisco to representatives of those jurisdictions in August at the state steering committee meeting in San Francisco. We are currently processing the contract with Costas for the next step as defined in the SOW. Los Angeles is well on their way to having a full bore tsunami mitigation and preparedness program. Other jurisdictions are making slow progress

HAWAII

Subject: Re: Hawaii Inundation Mapping Progress Report
Date: Wed, 01 Nov 2000 07:50:38 +0000
From: cheung@oe.eng.hawaii.edu
To: gonzalez@pmel.noaa.gov
CC: byanagi@scd.hawaii.gov, teng@wiliki.eng.hawaii.edu

Frank,

Below is the short report you requested. Thanks.

Fai.

HAWAII - Distance Tsunamis

This project develops a methodology to assess the potential threat to Hawaii of a tsunami in progress given near real-time data from water level stations near the tsunami source. The approach is based on the inversion or Green's function method that is commonly used to determine the seismic source parameters from water level or seismic records. This study extends the method to use the water level records to predict the tsunami waveforms at a number of observation points around the Hawaiian Islands. In addition, the jackknife least-squares technique is used to provide confident intervals of the predicted waveforms.

The Cornell Multigrid Coupled Tsunami Model developed by Prof. Philip L.-F. Liu is used to generate a database of synthetic waveforms at selected water level stations and observation points. Water level stations located in restricted waterways and harbors, where the recorded water level might be highly distorted by local conditions, are not used in the analysis. The work for the Aleutian-Alaska source region has been completed. The database of synthetic waveforms and the methodology have been verified for internal consistence using hypothetical events. Water levels recorded near the tsunami source and Hawaii after the 1964 Alaskan earthquake are being used to test the practical application of the approach.

November 2000 Progress Report
Local Tsunami Inundation Mapping—Hawaii

Gerard J. Fryer, University of Hawaii, Manoa

Dealing with local tsunami hazard in Hawaii presents formidable problems. Any earthquake larger than about magnitude 6.5 is potentially tsunamigenic. Because travel times are so short—Kona to Honolulu is only half an hour—warnings will have to be made rapidly with incomplete data. But because evacuations themselves are hazardous, especially rapid, panicked ones, it is essential that the false alarm rate be kept low. Discriminating between tsunamigenic and non-tsunamigenic events is therefore an important aspect of this modeling.

Accomplishments:

- Simulation of the Kalapana tsunami of 1975 has been completed and provides a useful verification of techniques and source parameters. In agreement with *Ma, et al*. [1999] (who looked only at tide gauge data), this study found that submarine displacements had to be much larger than the geodetically measured deformation at the coastline to satisfy the observed runups along the coast.
- By applying the Kalapana source to the Kona (west) coast of the Big Island, and with appropriate scaling, a variety of Kona and South Kona events have been modeled. Wave height and wavelength so delicately depend on source parameters that it has become necessary to perform a full sensitivity analysis by running multiple models at the Maui High Performance Computing Center. This is ongoing. Most of the events simulated produce damaging tsunamis, even in Honolulu, but there is need for caution: the inferred hazard is not reflected in the historical data. For example, the $M_S = 6.9$ Kona earthquake of 1951 produced such a small tsunami that only minor damage occurred along a short section of the immediate coast. Before any change in emergency procedures is warranted, the possibility of rapidly differentiating between 1951-type events and major tsunamigenic events like 1975 has to be explored.
- Inundation maps for Honolulu are now being produced.

Because people in Hawaii, especially teachers, are interested in this work, all the above findings are reported on the web at www.soest.hawaii.edu/tsunami/. Representative new results are posted to the web within a few days of becoming available.

Future work

This project is significantly behind schedule because of the difficulty of obtaining and merging good quality shallow water bathymetry. The work will continue, as fast as funding permits.

Within the next few months the following should be accomplished:

- Definition of the range of source parameters for tsunamigenic earthquakes along the Kona coast.
- Inundation mapping for the following regions (these maps will be passed on to the county GIS managers):
    - Kona coast (crude, because of poor bathymetry)
    - Honolulu
    - South Maui
    - Hilo
- Through discussions with State and county emergency managers, the Pacific Tsunami Warning Center, and the Pacific Disaster Center, to define the optimum responses to local tsunamis.
- Runup mapping for a major sector collapse of Kilauea volcano. This is not important for emergency planning purposes, but it has great educational potential, and it is what visitors to the web site and to the Pacific Tsunami Museum always want to see.

Not scheduled, but still of interest, are the generation of local tsunami inundation maps for Lihue, the southwest coast of Kauai (which appears prone to inundation from South Kona tsunamis), and Kahului (which appears prone to inundation from tsunamis from wave-triggered submarine landslides down the north slope of Molokai).

OREGON

Subject: Tsunami Hazard Mapping Progress: FEMA-NOAA-supported work in Ore gon

Date: Wed, 01 Nov 2000 09:31:33 -0800

From: Priest George <george.priest@dogami.state.or.us>

To: "Gonzalez Frank (E-mail)" <GONZALEZ@pmel.noaa.gov>

CC: "Myers Edward (E-mail)" <emyers@amb4.ccalmr.ogi.edu>, "Baptista Antonio (E-mail)" <baptista@ccalmr.ogi.edu>, "Clark Lu (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_Lu@dogami.state.or.us>, Hofmeister Jon <ryanjh@dogami.state.or.us>, "Madin Ian P (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_Ian@dogami.state.or.us>, "Olmstead Dennis (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_Dennis@dogami.state.or.us>, Roddey James <james.roddey@dogami.state.or.us>, "Staub Paul (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_Paul@dogami.state.or.us>, "Wang Zhenming (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_zwang@dogami.state.or.us>, "Wermiel Dan (E-mail)" <IMCEAMS-DOGAMI_PORTLAND_DanW@dogami.state.or.us>, "Wiley Tom (E-mail)" <IMCEAMS-DOGAMI_GRANTSPASS_tom@dogami.state.or.us>

After several preliminary technical reviews of early simulations, final numerical simulations are complete for Coos Bay, and inundation lines are being drawn for a preliminary field check and review. A field review with the Coos County Emergency Manager will occur November 5. A local government advisory committee meeting will follow on November 6, 2000. Digitization of inundation polygons should be done near the end of the contract, December 1, 2000. Final publication will occur some time after this, depending on time needed for outside technical review and publication priorities at Oregon Department of Geology and Mineral Industries (note that the contract supports only numerical simulations, not publication). I will let Antonio, Ed Myers, and Tim Walsh bring you up to date on progress for the Washington simulations. At last check critical bathymetric data for these simulations still had not arrived from NOAA and other sources.

Regards,

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WASHINGTON

Subject: WA report
Date: Tue, 07 Nov 2000 06:28:41 -0800
From: Antonio Baptista <baptista@ccalmr.ogi.edu>
To: gonzalez@pmel.noaa.gov
CC: Antonio Baptista <baptista@amb24.ccalmr.ogi.edu>, Ed Myers <emyers@ccalmr.ogi.edu>, Tim Walsh <twgg490@gwgate.wadnr.gov>, George Priest <george.priest@state.or.us>, titov <titov@pmel.noaa.gov>

Coarse resolution simulations were completed for the Straits of Juan de Fuca. Results will be made available to the state of Washington by the end of November, and provide qualitative guidance for tsunami propagation in the region. Late delivery of bathymetry and topography data delayed detailed simulations, which we consider necessary for sufficient resolution and confidence on results at the scale of local communities.

We anticipate that fine resolution simulations for the communities of Port Angeles, Port Townsend, Neah Bay and Quileute will be completed by late January. Neah Bay and Quileute constitute extensions of the initial scope of work. We are currently in the process of translating bathymetric and topographic data into appropriate computational grids. Grids are unstructured, and typically complex and time consuming to generate. New grid generation software, AGrid (Zhang and Baptista, 2000), already used successfully for Coos Bay, OR, has substantially reduced the labor required for the generation of the grids. However, concatenation and manipulation of the very large data sets of bathymetry and topography remains a time-consuming and logistically complex task.

Reference:
Zhang, Y. and A.M. Baptista, 2000, An Efficient Adaptive Editor for Unstructured Grids, 7th International Conference on Numerical Grid Generation in Computational Field Simulations, Whistler, BC, Canada

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